can well imagine that most of Boyle's energies must have been given to that pursuit. We hear distinct voices from the self-conscious remains of the Boyle archive, catching only distant echoes of a few others.

Hunter's Boyle will therefore be open to further interpretation. For example, I think it would be possible to bring Boyle's medical interests closer to the center of the life. Hunter shows that Boyle's later personal account dated his early interest in natural philosophy to 1640, when he was in Geneva on his Grand Tour and read Seneca's *Natural Questions* (pp 49-50). But Hunter also shows that the work-diaries indicate that he started experimenting only in 1649, mentored by a number of medical practitioners who took an interest in chemistry. His last works were also devoted to medicine, and in between he learned anatomy and physiology by dissecting with William Petty in Dublin in 1653 or 1654, while (as Hunter shows clearly) his most famous early work, the *Usefulnesse of Experimental Naturall Philosophy* (1663) was organized according to the genre of medical textbooks known as the *Institutes*. During the 1660s and 1670s Boyle was often linked to the apothecaries and chemists who were fighting their public wars of liberation against certain older traditions of medical physic, while in this period, too, the famous "English Hippocrates," Thomas Sydenham, associated his own work with Boyle's. But given Hunter's care to stick to the stated evidence of the Boyle papers rather than to pursue other hints, speculation about these and other associations which might illuminate some parts of Boyle's political and intellectual agenda is declined.

Hunter's Boyle therefore remains a rather aloof, exacting and industrious corpuscularian, the investigator of nature for its own sake, or rather for how it might support belief in the true God in the face of both doubt and sectarianism. One will find no Boyleian hidden agendas or conspiracy theories here, only an intelligent, earnest, open and non-doctrinaire member of the Anglo-Irish establishment. While it will not be the last interpretation of Boyle, then, Hunter's version of his Life and Works can be counted on for its full and scrupulous treatment of the evidence as we have it. Hunter's own integrity and discretion gives the work an enduring strength. Boyle himself would surely have been pleased with it.

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Atoms in Chemistry: From Dalton's Predecessors to Complex Atoms and Beyond. Carmen J. Giunta, Ed., ACS Symposium Series 1044, American Chemical Society, Washington, DC, 2010, vii + 116 pp, ISBN 978-0-8412-2557-2, $150.

Anniversaries are difficult to pinpoint, since discovery and publication may be separated by several years, and the history of chemistry is rich in multiple discoveries. Who discovered the composition of water? Who discovered oxygen? These discoveries were contested originally, then by generations of chemists and historians. But there is no question that the chemical atomic theory, according to which each element was indecomposable, and characterized by atomic weight, was the invention or discovery of John Dalton, and made sense of his laws of multiple and definite proportions. There is more than one possible answer to the question of when he invented his atomic theory, but he first published his own detailed statement of the atomic theory in 1808, and 2008 saw the ACS Symposium celebrating the bicentenary of that publication, followed in 2010 by the publication of this slender volume.

Carmen Giunta's introduction notes that unlike Dalton's atoms, today's chemical atoms are divisible; that atoms of the same element may exist as isotopes having different weights; that some elements are far from permanent, thanks to radioactive decay; but Dalton, were he alive today, could still take comfort from the fact that our atoms, like his, are discrete.

Scanning probe microscopy and manipulation enable us to "see" and to place individual atoms. This volume doesn't extend to nanotechnology, but it still covers a huge range. As William B. Jensen points out, atomism was seeping into chemical thought for almost two centuries before Dalton. One could argue for a longer pedigree, looking at medieval notions of least particles.

Gravimetric atomism was Dalton's invention, but there were problems in its application, resolved following Cannizzaro's solution at the Karlsruhe conference. Jensen notes that atoms prior to the 20th century were assumed to be spherical, whereas once electrical atomism was developed, the shape of atoms and electron orbitals became important for an understanding of bonding.

Leopold May looks at atomism before Dalton, in India, ancient Greece, Arabic alchemy, and medieval Europe. He gallops through the period from the 16th to the 18th century, which is fair enough since Jensen covers that period. There is, however, much recent literature that May doesn't mention, including studies of medieval atomism (William Newman's contributions here are notable), and more generally of atomism within alchemy and early chemistry or chymistry.

David Lewis looks at a century and a half of organic structures. Kekulé, Couper and Butlerov all distinguished the physical structure of molecules, which they regarded as unknowable, from chemical structure deduced from bonding affinities. There are some nice insights in this chapter, including the observation that Couper broke ranks from the theory of types, and that his excellence as an experimental chemist gave ammunition to critics who for years, ignoring his detailed instructions, failed to reproduce some of his key results. Chemical structure became physical structure only after 1874 and the work of Le Bel and van't Hoff.

William Brock's chapter, revisiting the atomic debates, is also a delight. He notes that chemists may have been agnostic about physical atoms, but that conventional atomism characterized and was essential to their chemistry. He notes, with Alan Rocke, that physical and chemical atomism increasingly provided mutual support by consilience. Benjamin Brodie's calculus of chemical operations was, as Kekulé pointed out, based upon initial assumptions, which, if altered, produced different results. It was therefore arbitrary in a way that chemical atomism was not. Kekulé also objected to Brodie's approach because it led to unnecessarily complex consequences. Chemists learned their chemistry using the atomic theory, and they tended to ignore those who, like Ostwald, opposed that theory. Even Ostwald, with his dynamic theory, made use of chemical atoms; and after the discovery of Brownian motion, he confessed the error of his ways, and adopted chemical atomism.

Carmen Giunta looks at the period from the 1890s to the early 1930s, in which the compound nature of atoms was elaborated and the electron, proton, and neutron were identified experimentally, and radioactivity and isotopes were first understood. Here were answers to problems that had bothered chemists for many decades. Atomic weights came close to integral values in a pattern that demanded explanation; but some atoms, like chlorine, had far from integral weights. J.J. Thomson worked with cathode rays, and determined the charge and the mass of the electron. Rutherford and Geiger explored the scattering of α particles, and in 1911 Rutherford published an account of the scattering of α and β particles, along with an account of the structure of atoms. Protons, as Giunta notes, were observed long before they were named, whereas the opposite was true of the neutron.

Gary Patterson looks at the physical evidence for atoms, from the kinetic theory of gases and van der Waals forces; from spectroscopy (Faraday to Geissler), leading to an understanding of internal vibrations; cathode rays (Crookes); scattering (Becquerel, Rutherford, and Perrin); X-ray diffraction; atomic spectroscopy; radioactive decay; and mass spectrometry. Each experimental technique not only reinforced a sense of the reality of atoms, but also deepened understanding of the nature of atoms. We have come a long way from Dalton.

The final chapter offers "A Selection of Photos from Sites Important to the History of Atoms." Jim and Jenny Marshall offer an engaging travelogue.

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